SUPPLEMENT.

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FORMING A COMPLETE RECORD OF THE PROCEEDINGS OF ALL PUBLIC COMPANIES.

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Original Correspondence.

BIRMINGHAM, AND THE BLACK COUNTRY—No. III.

THE EARL OF DUDLEY'S WORKS.

The article in the Supplement to last week's Journal terminated with the description of the roll store at the Round Oak Ironworks. In the immediate rear of the roll store there are five large kilns for calcining the forge cinder, or bulldog. These kilns are necessarily very substantially built, and are so constructed as to bear the intense heat, and last a long period. Near the kilns there is a crushing-mill, driven by a small horizontal engine, with a 12-inch cylinder, and working a 2 ft. 4 in. stroke. The cinder on coming from the works is burnt in the above kilns, and then taken out and broken or ground in the mill, from whence it goes to the puddling-furnaces to be used as fettling. The new forges, which are part of and situate near to the Round Oak Works, have been built about five years. They were erected in order to supply a sufficient quantity of puddled bars to keep in advance of the work. These forges are laid out upon a first-class principle; the puddling-furnaces, twenty-eight in number, are arranged in a semicircle, the engines, forge-trains, helves, &c., being placed as near as possible about the centre of the diameter. By this arrangement all the furnaces are placed at almost an equal distance from the helves, and yet all are as near as it would be advisable to get them. The advantage of this will be seen, for there is no confusion. A puddler, when drawing his heat, has not to cross the standing-place of another in order to get his balls to the helve; he has only a short distance to take the balls, over a clear space, and they are consequently soon under the helve, and are little subjected to the oxidising effect of the atmosphere. The vertical forge-engines are placed side by side; they have cylinders 27 in. diameter, and work 2 ft. 4 in. stroke. Steam is supplied to the engines by six cylindrical boilers, 35 ft. long by 5 ft. diameter. These are placed at some little distance behind the engines, and clear of the works. The plan of having the boilers at the back of the works, and at some distance from where the men are at work, is adopted throughout the whole of the Round Oak Works, and nearly the whole of the boilers are firing boilers. These are two noticeable features, for were other works laid out upon the same plan there would be fewer boiler explosions, and less destruction to life and property should an explosion occur. Furnace boilers, in which the waste heat is utilised, are not to be condemned when rightly constructed, and placed in a proper position. It is well known that in the majority of ironworks most of the furnace boilers are in the midst of the works, so that a large number of men are engaged close round them; they are also surrounded with puddling furnaces, and so built up that it is almost impossible to ascertain the state they are in.

The only two furnace boilers at the Earl's works are placed horizontally over heating furnaces; they stand out away from the works, so that their ends only are directed towards where the men are working, and they are so constructed as to be easily inspected. No. 1 machinery, at the new forges, consists of one 4-ft. pinion on the fly-wheel shaft, working into a 11-ft. wheel upon an intermediate shaft; a 16-ft. wheel upon the cam-shaft is worked into by the 11-ft. wheel. The cam on the cam-shaft is supplied with four arms, and lifts a 6¼-ton helve. To this machinery there are all the necessary standards, harness, chocks, anvil-block, cup, hammer, anvil, carriages, race-plates, and foundations of oak and elm. The forge-train, consisting of three sets of rolls, is worked from the end of the above-mentioned intermediate shaft, and is thoroughly fitted with all the required appliances. No. 2 machinery is similar in every respect to No. 1, with this exception—there is a 9 ft. 6 in. wheel upon the intermediate shaft, instead of the 11-ft. one. No. 2 forge-train is scarcely so strong as No. 1, as it is not intended to roll so heavy bars. The whole of these forges are covered with strong slated roofs, mounted upon cast-iron columns. To Mr. Richard Smith, Casson, the entire management of the works is entrusted, and he has during his term of office made several general improvements. The Round Oak Works is one of the best, if not the best, ironworks in the kingdom. The arrangement of the plant is almost perfect, but we think it possible that improvements might have been made in the machinery; the engines in some instances should have been larger, and made to work expansively, and the mill for rolling the heavier classes of iron, such as rails, would have been better had it been of greater dimensions, and had more furnaces to it. The quality of the iron made at these works, for some purposes, cannot be surpassed; it is not only good in quality, but uniform in character. Large quantities of puddled steel or crystalline iron are made here, and of such a quality that it has for several purposes supplanted cast-steel. The Earl's iron was, we believe, awarded the first prize at both the Paris and the 1862 Exhibitions. The samples of iron at the works, showing the tests to which it can be put, are a complete study. A handsome suite of offices, capable of accommodating about 40 persons, stands near the works, and answers not only for them but for a portion of the Earl's collieries.

It will, perhaps, not be amiss here, after having described an important ironworks, to give a brief account of the manufacture of wrought-iron from pig-iron. This may be looked upon as a strange proceeding for a scientific journal, yet we are aware that many of our readers are strangers to the process, and while others may understand the matter practically, few are, comparatively speaking, acquainted with the theory. When pig-iron is brought to the forge there exists in it many impurities, which are more or less injurious, and these have to be removed before it reaches the consistency of wrought-iron. Puddling, or pig-boiling, is the general means resorted to to accomplish this purpose. The main impurities existing in pig-iron are manganese, phosphorus, silicon, sulphur, calcium, arsenic, and carbon; these, of course, vary according to the nature or quality of the ore from which the iron is produced. Most of the impurities mentioned are removed in the puddling-furnace, but the principal duty it has to perform is the removal of the carbon. The quantity of carbon contained in pig-iron averages from about 2 to 5 per cent. The carbon is extracted from the iron when in a molten state, by being brought into contact with oxygen, and this, on account of its chemical affinity, it readily unites with. The requisite oxygen is supplied from two sources—firstly, by the air passing from the fire-grate over the iron; and, secondly, by the ingredients placed in the bottom of the furnace before charging, such as hammer-slag or scrap-iron. The action of the oxygen can be seen during the puddling process by the jets of blue flame evolved from the surface of the metal, showing the existence of carbonic oxide. While the carbon is being eliminated a coating of oxide covers the surface of each portion of iron as it comes to nature, and were not means for its prevention to take place a large portion of the iron would soon become wasted. The action that prevents this is the conversion by oxygen of the silicon—contained in the pig-iron, adhering to the surface of the pigs in the shape of sand, and supplied by the materials constituting the furnace bottom—into silica; this latter substance unites with the protoxide of iron, and protects the iron from the wasting effects of the oxygen. The protoxide of iron uniting with the silica forms the tribasic silicate of protoxide of iron, or welding cinder, which in a fluid state covers the balls when drawn from the furnace, protects them from the oxygen of the atmosphere as long as they remain at a certain temperature, and makes them easy to weld one with another if necessary; for as soon as they are subjected to the blow of the hammer the covering cinder flies out, bringing the two clean surfaces of the iron together, so that they perfectly unite. The other impurities spoken of as existing in pig-iron are mostly cleared away by the action upon them of the oxygen. We have before noticed the average quantity or percentage of carbon in pig-iron; now, wrought or pure iron when properly manipulated should contain little or no carbon, it having been eliminated in the puddling-furnace. Steel—that is when cast—contains an average of from 0·5 to 1·5 per cent. of carbon. Puddled steel is made by stopping the process of decarbonisation at a certain stage in the furnace. There are other modes of making it by the use of chemicals containing oxygen. Steel, we need hardly remark, is made either by adding carbon to wrought-iron, or by extracting the whole of the carbon from cast-iron, and adding materials containing a known quantity.

SCOTCH IRONWORKS—THE PARKHEAD FORGE.

Parkhead is a suburb of Glasgow, about two miles distant from the centre of the city. It is known in the manufacturing kingdom chiefly on account of the forge, which is one of the largest establishments of the kind in Scotland, and upon which its population is mainly dependent. Like many other works which have gradually risen to a foremost place, the Parkhead Forge had a very small beginning, when it was commenced some 30 years ago. Under the management of the present proprietors, Messrs. Rigby and Beardmore, it has attained a very wide wide-spread fame for the size and character of its forgings, a great many of which have been done for the largest vessels in Her Majesty's Navy. There are about 1000 men employed, and on an average 300 tons of coal are consumed daily. The works are divided into the puddling department, the forging department, and the machinery shop.

THE PUDDLING DEPARTMENT.—It is upwards of 10 years since the existing buildings for puddling purposes were erected. There are 28 puddling-furnaces, and 2 mills for making plates and sheets which will turn out about 50 tons of plates per day. The mills are open on every side, the roofs of the two largest being 75 ft. span, supported on iron pillars and arched walls round the outside. The third mill is of smaller size, contains 12 furnaces, and was only erected about five years ago. Like the others, it is supported on iron pillars and arched walls, while the roof is constructed of wrought-iron and tiles, thereby avoiding all danger of fire. There are some single puddling-furnaces, but the majority of them are double. Two are built on Siemens's regenerative gas principle, another is constructed on Gorman's patent. In this connection we may note that Mr. Healey, engineer, is now erecting six producers and two furnaces on Mr. Siemens's principle in another part of the forge. From what they have seen of the furnaces already in operation, Messrs. Rigby and Beardmore anticipate the most successful results from Mr. Siemens's system. In accordance with the patentee's plan, the producers are being built entirely separate from the furnace where the heat is required. Gorman's heat-restoring gas-furnace has not been found to work so well, and complaints have from time to time been uttered against it by the men. The latter furnace contains a grate so constructed that it can be used while the furnace is working. The bars are horizontal, supported on the bearers, nearly a third of the length of the bar from the ends. The bars are free at each end, with an open space above, through which ashes or clinkers can be drawn. The bars have room to slide along nearly a third of their length, and can be drawn out or replaced when wanted. The leading features of both furnaces have already been described, and we need only indicate here that at the Parkhead Forge a decided preference is given to the invention of Mr. Siemens. The remaining 25 furnaces are of the ordinary kind. The *modus operandi* adopted in this department is very simple. The pig-iron, which is supplied from various large works in the district, including those of Govan, Gartsherrie, Monkland, Coltness, and Summerlee, is first converted into rough puddled bars. It is then piled in weights for the various sizes of plate, and afterwards it has to be passed through the plate-mill. There are two of these mills in almost constant use, the one being adapted for 20 and the other for 22-in. plates. A horizontal engine of 300-horse power drives the mills, while 20 overhead boilers supply the steam necessary to put in motion two of Rigby's patent steam-hammers—one 2½ and the other 3 tons—and other appliances. A smaller engine is used for driving the shears. The waste heat from the furnaces is utilised in generating steam in the boilers. The Parkhead Plate-Mills are at the present time the largest in Scotland, but new mills are being erected at Blochairn, which are expected to be still larger.

THE FORGE DEPARTMENT is contained within a rather irregular pile of buildings, erected at different periods, as the requirements of the works increased. It is separated from the plate-mills and furnaces by a large open space, and is covered by wood and tiles, the roof being supported on iron pillars. Among the appliances at work here are a shingling-forge, where the iron is prepared from scrap into slabs and blooms, and one of the most powerful shears in the country. The latter is capable of cutting through a bar of cold iron 4 inches square. It is self-acting, being driven by a small engine, to which it is attached, and which can get up a speed of 200 revolutions per minute in the fly-wheel. Besides this shears (which, by the way, was made at Parkhead Forge), there are several benches, where the scrap is hand-picked by a number of men and boys, and then piled to the height of 12 by 18 inches. After being hand-picked the scrap is put into the furnace, from which it is taken to the steam-hammers and shingled. These steam-hammers form one of the most notable features of the forge. In the forging department alone there are no fewer than 11 steam-hammers, some by Nasmyth and others by Rigby, varying in power from 30 cwts. to 7 tons. They are connected with powerful steam-cranes, capable of carrying from 10 to 60 tons weight. It is said that this forge contains a greater number of steam-hammers than any similar establishment in the kingdom, although neither the Mersey, the Dumbarton, nor the Lancefield Forges are far behind. A spacious smiths' shop is connected with the forging department. Here there are five more cranes by Forrest and Barr, varying in capacity from 8 to 12 tons, and 12 horizontal boilers, from 24 to 30 ft. in length and 6 ft. diameter. The boilers are covered over with brickwork, and constructed on the tubular principle. In this portion of the works very heavy forgings are executed. One of 35 tons weight was some time ago done for Her Majesty's ship Sultan; and there is now on hand a large shaft, of 35 tons weight, for an American firm. The largest diameter of the latter forging is 31 in., the smallest 24 in., and it is 38 ft. 6 in. long. Stern-frames, weighing from 30 to 42 tons, and stems weighing from 10 to 20 tons, are frequently forged. Work of this kind has been executed at the Parkhead Forge for the Black Prince, Hector, Hotspur, and other ships of Her Majesty's Navy. Messrs. John Elder and Co., the eminent shipbuilding firm, are now building an addition to Her Majesty's Navy, to be named the Hydra, for which heavy forgings are being executed at the Parkhead Works. Crank-shafts and engine forgings are the staple articles of manufacture; and from the Tyne and the Thames, as well as from the Clyde, numerous orders for forgings of this description are received.

THE MACHINERY SHOP is the only other department remaining to be described. This building stands entirely apart from the others, and measures 250 feet long by 45 feet wide. The roof is iron-bound, and of one span. The shop contains turning, boring, planing, and slotting machines. A travelling-crane passes on a line of rails from one end of the building to the other, so as to bring the forgings under the operation of the different machines. This crane is capable of carrying 20 tons, and when necessary it can be worked up to 30 tons. All the machinery is driven by a powerful vertical condensing-engine. A valuable addition is now being made to the existing plant, in the shape of a large turning-machine, capable of turning pins and cranks with such nicety and smoothness as to ensure their being perfectly round. Those engaged in engineering and various kinds of forge work will fully understand the importance of having true pins. The boring-machine is exceptionally powerful, as may be judged of by the fact that it can drill a 10-in. hole through a solid block of iron. It may be interesting to mention that Messrs. Rigby and Beardmore are now executing forgings for the new yacht, which is being engined for Her Majesty by Messrs. Maudslay, Sons, and Field, of London.

The works cover in all about 19 acres of ground. Near to the mills about a dozen houses have been erected for the foremen over the various departments. In another place several kilns have been erected, for burning the fettling for the furnaces. Fire-clay mills are likewise erected, for grinding the fire-clay used in the furnaces; while the indispensable accessories of pattern and joiners' shops are provided in suitable proximity to the rest of the works. The whole premises are intersected by lines of railway, and several locomotives are continually employed in removing coal and iron to and from the Forge.

COLLIERY WORKINGS IN NORTHUMBERLAND.

The four collieries of Cambois, North Seaton, Cowpen, and Newsham—of which the Cowpen and North Seaton Coal Company are the lessees, and Mr. G. B. Forster the chief viewer—are situated at the eastern part of the steam coal district of Northumberland. The royalties in connection with them are bounded by the German Ocean on the east, by the Bedlington properties on the west, and by Seaton Delaval on the south. Of the four collieries the most noteable is—

CAMBOIS COLLIERY, which has been 3½ years in operation. Two pits are sunk, 29 yards apart from their centres, 105 fms. in depth to the Low Main seam. The downcast pit, 15½ ft. in diameter, is divided by wood brattice into two compartments, 6 ft. of this being appropriated as a pump shaft, the remainder for coal work. The other pit is 14 ft. in diameter, and is used exclusively as an upcast from the boilers and engines placed near the bottom of it. One condensing lever winding-engine is erected at the coal pit; it has a 65-in. cylinder, 7-ft. stroke, wrought-iron levers, cylindrical drum 22 ft. in diameter, fly-wheel 24 ft., break-strap half round the wheel, acted upon by a 9-in. steam piston and powerful lever. The engine-house is built with ashlar stone. The intermediate framing to support the drum and wheel is formed with two wooden girders, wrought-iron struts, and cast-iron columns, all being held together and to the foundation by strong bolts. Instead of the front lever a hollow wrought-iron beam is substituted for pumping, which is connected to another beam outside the house, extending between the pit and a staple at its back end. The gauges indicate the steam pressure 20 lbs., vacuum 13 lbs. per inch. This engine was made at J. and G. Joicey's works, Newcastle, in 1864; it raises the unprecedented quantity of 1600 tons daily in 12 hours work, and has once raised 1800 tons. Two-decked cages are used, made of steel; each cage carries four 13-cwt. tubs, runs on two rails as conductors at one side of it, and for lifting these 6-inch round wire-ropes are used. The durability of the ropes is found to be much increased by india-rubber cushions placed under the brasses of the pulleys; four layers, each 2 in. thick, are placed under each brass. The pumps in connection with the winding-engine are in two lifts; the lower lift (in the pit) is 53 fms., 16-in. bucket; the upper lift (in the staple) is 55 fms., and 20-in. bucket; at present these are not used. The water is raised by the pumping-engine placed underground. The capabilities of the winding-engine for raising coal, the screens, and iron erections have made this colliery an object of interest to many mining men. There are 15 coal screens, and an inclined elevator to the nut screen; these, with the pulley frames, heapstead, flooring plates, and roofing are of wrought-iron. The platform is 21 ft. above the rails, and is supported by cast-iron columns; the sides are enclosed with galvanised sheet-iron.

A winding-engine is placed at the top of the upcast pit; it has two 24-in. horizontal cylinder, 5-ft. stroke, direct-acting, non-condensing, 14-ft. cylindrical drum, foot-break, acting round each side

of the drum. The slide valves are worked by eccentrics and slot links. The crab-engine has one 14-in. horizontal cylinder, 2-ft. stroke; it works one 3-ft. drum on second motion, wheels in ratio of 1 to 4 for the jack rope, and another 4-ft. drum on third motion, wheels in ratio of 1 to 4 for the crab rope; the latter is of galvanised steel wire. The large condensing-engine is supplied from four Lancashire boilers, 35 by 7 ft.; the two non-condensing engines from two plain boilers, 30 by 6 ft., all are hand fired. The chimney is 109 ft. in flue height, 7 ft. internal diameter. The pumping-engine, before referred to, is placed between the pits in the Low Main seam, and is from R. and W. Hawthorn's works, Newcastle. It has two 22-in. horizontal cylinders, 5-ft. stroke, direct acting; it forces water to the surface by two single-acting ram-pumps, 9-in. diameter, 5-ft. stroke, and 13-in. main pipes in the pump shaft. The engine makes 13 strokes per minute, day and night. At the opposite end of the cylinders, by means of connecting-rods and two quadrants; it works a lift of pumps from the Plessey seam, 10 fms. below the Low Main; these are two 10½-in. close-topped lifts, 4½-ft. stroke, delivering at cisterns near the engine. The engine is supplied with steam at 75 lbs. pressure by two Adamson's double-flued boilers, 20 by 6 ft., and two other boilers, with 41-3 in. brass tubes in each, and copper fire-box; these are placed near the engine.

The hauling engine—one of Fowler's portable class—is placed about 60 yards from the bottom of the downcast. It has two 14-in. horizontal cylinders, 16-in. stroke, wheels in ratio of 1 to 3½, two drums on one shaft, 6 ft. in diameter, 2½ ft. wide; these are put in or out of gear by two clutches. The boiler connected with the engine has a copper fire-box, 42-3 in. brass tubes, and supplies steam at 110 lbs. pressure. The feed water for the boilers is brought from the surface in 2-in. wrought-iron pipes; the pressure at the boilers is 280 lbs. The hauling engine works direct to the west bank, 300 yds. in length, with one drum and rope. With the other drum, and the rope passed round a 7-ft. sheave, it hauls from three separate districts, the empty tubs run inwards by gravity in each case; it pulls from the north-west district, 800 yards inbye from the shaft, and three short branches out of it; from the north bank, 700 yards in length, in a direct line from the shaft; and from the north-east district, 400 yards in length, with one branch from it; the branches are in each case about 50 yards in length. The north district is drained by two 6-in. ram pumps, 12-in. stroke, placed near the extremity; these pumps are worked in one lift by a 4-ft. clip wheel on the engine-shaft, and an endless wire-rope from thence to the pumps. The north-west district is drained by one of Warner's horse cranks, and three 4-in. ram pumps; and the north-east district is drained by an underlevel drift, which commences from the Plessey seam at the pit. The Low Main workings extend about one mile south of the pits. In 200 yards of this distance, next the pit, a self-acting incline, rising 2½ in. per yard, is in operation, beyond this the gradient is nearly level, and horses are employed for hauling; there are altogether 15 horses and 64 small ponies employed in the mine. A whin dyke passes through this mine 800 yards south of the pits; the vein of whin is 9 yards in thickness, and the coal on each side of it for 14 yards is charred, indicating that the intrusion of molten matter has occurred subsequent to the coal formation. Unlike the great 90 fathom dyke, the quality of the coal on the north and south sides of the whin dyke is not materially changed further than this, and the seam is not altered in its horizontal position. Section of the Low Main seam in the north-west district of the mine:—

	Ft.	in.	Ft.	in.
1.—Blue metal, good roof.				
2.—Grey coal	0	7		
3.—Good coal	3	3½		
Parting.				
4.—Good coal	1	8	=5	6½
5.—Holing fire-clay			0	2
6.—Bad coal			0	5
7.—Under clay			2	6
8.—Post.				

This fine seam of coal is all of the first quality, excepting the grey coal, which is separated as second-class steam coal. The dip of the measures is here to north-west, in some parts 1½ in. per yard; but this appears to be irregular, and they are sometimes nearly level. The cleavage is about north 35° west, or south 35° east throughout the mine; the bords are driven at right angles to this. On the north side of the pit the coal is got on the bord and pillar system; the pillars are made 30 by 24 yards, the bords 6 yards in width, reduced to 4 yards at each end, and the walls 2 yards in width. The bords are usually driven to south-west in panels of twelve, the wagon-road being in the middle of the panel. The pillars are worked off (in some cases close after the whole workings) either in one lift, 24 yards wide, from each end of the pillar, meeting in the middle; or the lifts may be taken in twice, or 12 yards in width, from each end. Powder is used in all the workings, candles are in use in the whole and lamps in the pillar workings. On the south side of the pit the coal is got in part on the long wall system. A series of twelve faces, 20 yards in width, forming a breadth of 240 yards under operation; the faces are driven in advance of one another, with a road in each, supported by pillaring and chocks; three rows of chocks are set up at the face. The permanent roads are made 100 yards apart. It has been laid down as maxims in coal working that coal should be got on the long wall system, worked on the end, and the holing made in the under-clay. Though these rules cannot always be acted upon, in many instances they may be put in practice with advantage towards making a greater percentage of large coal, and in simplyfying the arrangements for ventilation. The production of fire-damp at these collieries is small in comparison with some of the northern mines; and no fatal accident has occurred at Cambois Colliery either from gas or falls of stone or coal. These important results have been attained in a great measure by strictness in discipline, and by every man being attentive and at his post; and this is imperatively required where safety is to be obtained. The air in circulation in Cambois Mine amounts to 100,000 cubic feet per minute; this is derived from rarefaction of the upcast column, heated by the boiler fires and escape steam from the engines. Two 8-ft. furnaces are prepared, to be lighted in case of stoppage of the present means of ventilation. About 30 fms. of cast-iron tubbing is inserted in each pit, in two lengths, commencing at about 100 ft. from the surface; the remainder of the pits is principally walled. Gas works are erected at the top of the pit, from which, by branch pipes, gas is conveyed to the bottom of the pit, to light the principal roads at the bottom, the engines, and boiler chambers.

Brick Works.—About 6000 bricks are made per day at the works adjacent to the colliery; the raw material used is from the roof and thill of the Low Main seam. The clay-mill is of the usual type; it is driven by a 12-inch horizontal engine, with one boiler. The drying shed has eighteen fires on each side, and flues communicating with two chimnies in the centre. There are eight kilns, with separate chimney; each kiln is heated by three fires in front, and will hold 8000 ordinary bricks. Drainage pipes of various sizes are also made and moulded by hand.

North Seaton Colliery has been ten years in operation. Two pits are sunk, 10 yards apart, 126 fms. in depth to the Low Main seam. The downcast pit is 15½ feet in diameter, divided by wood brattice for pumps and coal work respectively; the other pit, 9 ft. in diameter, is used exclusively as the upcast column for ventilation with a furnace. The winding-lever condensing engine is from the works of T. Murray and Co., Chester-le-street, it has 60-in. cylinder, 7-ft. stroke, 21-ft. cylindrical drum, and fly-wheel, foot break; the intermediate support for the drum and wheel is a wall of ashlar stone. The front lever is extended as a beam through the wall of the house, to be connected to the pumping-beam outside. This engine is standing at present; two-decked cages are used, each cage carrying four 13-cwts. tubs; these run on two wood conductors. The pumping engine is a double-acting, condensing, two-beamed engine; the front beam is of wrought-iron, and was the first of that material introduced in this district, made by Fairbairn, in 1860; the back beam is of cast-iron. The cylinder is 76 in. in diameter, 8-ft. stroke; water is raised in three lifts; the lower lift is 56 fms., 18-in. bucket, 8-ft. stroke; the second lift is 63 fms., 20-in. forcing ram, 8-ft. stroke; these are in the pit worked from the end of the wrought-iron beam; the upper lift is 11 fms., 26-in. bucket, 5-ft. stroke, this is in a staple within the house, and worked from the inner side of the back beam, while the second shaft was being sunk 1400 gallons of water were pumped per minute by this engine. A jack-engine, with 14⅝-inch horizontal cylinder, wheels in ratio of 1 to 2, is used at the upcast pit in raising men. Fourteen screens are erected, eleven of these are of iron, the remainder of wood, the heapstead and other erections are also of wood. Four plain boilers, 35 ft. by 7 ft., supply the pumping-engine with steam at 18 lbs. pressure; four similar boilers are in connection with the winding-engine. Four plain boilers, two 30 ft. by 6 ft., two 28 ft. by 4 ft., supply the underground engine with high-pressure steam, by 8-in. pipes, fixed in the downcast pit. The hauling-engine is placed near the bottom of the downcast pit; it has two 20-in. horizontal cylinders, 3-ft. stroke, wheels in ratio of 1 to 1½. By means of a 9-ft. clip-pulley and a rope, it hauls 30 tubs at once on a plane 850 yards in length, on an irregular gradient; the ends of the rope are attached to the front and back of the train. A branch plane of 700 yards, with a separate lying rope, is also worked by this engine.

Cowpen Colliery comprises the A pit, B pit, and C pit. Coal working commenced at the A pit about 80 years ago; it has been standing now 16 years. One pit is sunk to the Plessey seam, 115 fms. in depth. A beam winding-engine is standing, with 33-in. cylinder, 5-ft. stroke. The A pit pumping-engine serves to drain the whole of this and Newsham Collieries; it has 72½-in. cylinder, 9-ft. stroke in cylinder and pit, 28-ft. cast-iron beam, and condensing apparatus; it raises water in two lifts, at the rate of four strokes per minute, going day and night. The lower lift in the pit is 53 fathoms, 24-in. bucket; the upper lift, in a staple directly under the cylinder, is 62 fms., and 24-in. bucket. Five plain boilers, 28 by 8 ft. supply this engine, all fired by hand. The B pit is 11 ft. in diameter, 97 fms. in depth to the Low Main seam. This has also been used for coal work from an early period; it is now used solely as an upcast for ventilating the Cowpen Mines by means of a furnace at the bottom of it. A lever condensing winding-engine is standing, of 30-in. cylinder, 5-ft. stroke. The C pit, a downcast and coal pit, has been 15 years in operation; its depth is 112 fathoms to the Low Main seam. The winding-engine is of the lever kind, with condensing apparatus, 55-in. cylinder, 7-ft. stroke; it raises coal from the Yard and Low Main seams, from the depth of 82 and 112 fms. respectively, with round rope drums of 14 and 9 ft. diameters. The drums and fly-wheel are supported on one side wall and an intermediate framework of wood. About 750 tons of coal is raised per day in two-decked cages, each cage carrying four 8½-cwt. tubs. Four plain boilers, 30 by 7 ft., supply the engine, at 14 lbs. pressure. The winding-engine was also adapted for pumping water by means of a pumping-beam connected with the front lever, which extends from the pit to a staple within the house; but the pumping is not required since the A pit engine commenced its operations. The lower lift is a 19-in. bucket; the middle is a 20-in. forcing-lift; these are in the pit. The upper lift is in the staple, with 20-in. bucket; the stroke in each is 4½ ft. There are nine coal screens, with iron bodies, at the C pit; the other erections are all of wood.

Newsham Pit has been nine years in operation; it is 15½ ft. in diameter, 100 fms. in depth to the Low Main seam, divided by wood brattice; 9½ ft. of this is apportioned for coal work, and is the downcast; the remainder is the upcast, from the ventilating-furnace and an engine at the bottom of it. There is underground communication also with the Cowpen pits. A lever condensing winding-engine, of 52-in. cylinder, 6-ft. stroke, 16-ft. cylindrical drum, 22-ft. fly-wheel, raises about 600 tons of coal per day in two-decked cages of steel; each carries four 10-cwt. tubs, and runs on two rails at one side of it as conductors. The intermediate support for the drum and fly-wheel was first a wall of ashlar stone, but this had to be removed, and a framework composed of wrought-iron and wood, with cast-iron columns, has been substituted. The front lever, of cast-iron, is extended as a beam through the wall of the house to adapt it for pumping; the pumps are not now used. This engine, with that at the C pit, are from the works of T. Murray and Co. Four plain boilers, 30 by 6 ft., are fixed. Another horizontal engine, used at first for winding, with 25-in. cylinder, 5-ft. stroke, 10-ft. flat-rope drums, is now disused. A 12-in. horizontal engine is used for the back shaft. A Fowler's engine is placed for hauling near the bottom of this pit; it has two 12-in. cylinders, 12-in. stroke, wheels in ratio of 1 to 3½, giving motion to an endless rope by means of a 7-ft. clip-pulley. The underground plane is about 600 yards in length; 30 tubs are run at once; half of the plane rises from the shaft; the inner portion falls inbye. The train is attached to the endless rope by two short chains at certain points. The mode of working coal is similar to that described at Cambois; the long wall system is in operation here also in part. Ten iron screens are erected at Newsham; the other erections are all of wood; the flooring-plates are of metal. Tubbing is also inserted in this pit.

The principal engine-houses at the Cowpen and North Seaton Collieries are built entirely of Ashlar stone. A large number of workmen's cottages have recently been built by the company in open and salubrious situations near the coast at Cambois and North Seaton; proper drainage is provided for them.

Coal is sent for shipment to the Blyth tidal harbour, to Hayhole Dock, on the Tyne, by the Blyth and Tyne Railway, or to Sunderland Dock by the North-Eastern Railway.

MESSRS. VIVIAN v. THE SWANSEA UNION.

Sir,—"Fair-Play's" remarks in the Journal of Nov. 19 has caused a rejoinder from the pen of Mr. Edward Strick (solicitor to the appellants), appearing in the *Cambrian* of the 2d instant, in which that gentleman informs the public "that if the Assessment Committee had appointed a professional valuer in the first instance, the litigation in this case, which, be it understood, has been nearly as costly to the appellants as to the respondents, would not have been heard of." What conclusion can the public arrive at from the above acknowledgment, but that the appeals were directed against the valuer personally, and not against the amount of his valuations?

It is not my intention to enter into the high tone displayed by Mr. Strick against the valuer, more than to observe that the personal remarks made against this officer are quite uncalled for, and I should have passed it over in silence had it not been for some assertions he made respecting certain arguments used by me in my former communication.

1.—That the conclusions I arrived at respecting the rental of the Forest Works were incorrect, inasmuch as the compulsory clause in the lease, to expend the sum of 3000*l.* in repairs or alterations, formed no element whatever of the rent. It would be well to examine this point carefully in another view. Supposing a person taking a lease of house and premises in a dilapidated condition, at the annual rental of 50*l.*, with stipulations compelling the lessee to expend (say) 1000*l.* in repairs or new buildings, would not the outlay in this case be an element of rental?

2.—That it was unfair on my part to insinuate that he withheld, or was unable to give, information respecting the number of furnaces, &c. This is best answered in Mr. Strick's own words—"'Fair-Play' is unfair when he insinuates that I withheld, or was unable to give information on the occasion of my making a formal appeal to the Assessment Committee. I did not attend for the purpose of going into an appeal of such magnitude at a general meeting of the committee, and with no other guidance than my own limited knowledge of such works. I went rather to complain of so great an alteration in an assessment recently decided upon, after considerable discussion, without previous communication with my clients, and to endeavour to arrange a special appointment for going into the case. I admit I did not go prepared to answer questions as to the number of furnaces, calciners, capacity of rolling-mills," &c. Thus Mr. Strick admits that the charge I brought against the solicitor of the appellants is fully proved; then why tax "Fair-Play" with unfairness? Mr. Strick also states that he attended the meeting of the committee, to arrange for a special appointment for going into the case; now, I am credibly informed that no such request was made to the committee, and, moreover, it would be a very easy matter for him, if he possessed the least desire to settle the question amicably, to produce the agents of the different departments; those persons, as a matter of course, possessed all the information necessary for the appeal, and, undoubtedly, if that course were adopted, much saving of expense would have ensued to both the appellants and the respondents.

Again, Mr. Strick says that a portion of the increased rateable value shown by me was for new works, and for which the appellants never objected to pay; but is it not a fact that the appeal was against every item that Mr. Davies valued? Subjoined is a table, showing the rateable value of the largest copper-works in the world, and the increased amount during the past seven years:—

	1863. Rateable value.	1865. Rateable value.	1870. Rateable value.	Increase in assessment in 7 years.
Hafod Copper Works	£837	£1088 10	£1530	£693
Hafod Rolling Mills	400	688 10	1296	896
Only 2 items appealed against	£1237	£1777 0	£2826	£1589

Swansea, Dec. 7. FAIR-PLAY.

COAL-CUTTING MACHINERY.

Sir,—In reply to the remarks of Mr. J. Rothery, in the Supplement to last week's Journal, I would say that they are merely an attempt to destroy public opinion respecting the abilities of my machine. For instance, he assumes to show that it has retrograded from the first reports down to from eight to ten yards per hour; but since he possesses so much of the thinking, knowing, and believing powers he will, perhaps, believe the following, which will account for the retrograde movement of which he speaks. The grooves cut are now three times the width of the former, of those in previous reports. There are many other points that I might put, but do not think it worth my time.

I should be obliged if you will publish a copy of the enclosed letter, as it will show to the public the true intentions of J. Rothery.

Mr. J. Rothery informs you that he has visited my works. This has been done neither with my knowledge or consent, or my manager's or cashier's knowledge, as no one is allowed to enter the works to view without a written order. F. HURD.

Albion Foundry, Wakefield, Dec. 8.

Waterloo Main Colliery, Leeds, June 3, 1870.—Sir: I beg to call your attention to my patent, dated April 13, 1868, No. 1219, wherein I secure, combined with my machine, an endless pitch chain, carrying a series of scrapers, which pass round two chain pulleys; and, if requisite, the pulleys may have spur teeth formed thereon, gearing into corresponding teeth inside the links of the endless chain. Rotatory motion is imparted to the pulley either by a small cylinder or by gearing, or any other suitable contrivance, and in no light whatever can your so-called "endless cutters" be anything but endless scrapers, the motion described by you being the reverse to a cutting motion. J. ROTHERY.

Mr. F. Hurd.

COAL-CUTTING MACHINERY.

Sir,—It would appear from Mr. Rothery's letter in last week's Journal that that gentleman found himself on the horns of a dilemma, and so had to wriggle off in a very clumsy manner indeed. His statement (which I impugned) "that the report of what Mr. Hurd's machine did in November last was greatly exaggerated," he does not now support, but falls back on the report of what it did in May, which was more. Thus, in fact, taking for granted, to suit his new argument, that the statement of the work performed in November by the machine *was correct*. So much for consistency, for another "shy" at the machine. As an inventor of coal machinery, Mr. Rothery says he has the greatest sympathy for all inventors of such machinery. If such is really the case, I must say that he takes a most singular way of showing it, for judged by ordinary rules most persons would term such sympathy as unmitigated hostility. I suppose it was a spirit of pure sympathy which led Mr. Rothery to consult a "proper authority" as to the validity of Mr. Hurd's patent as to the endless chain, and "to find that it was bad." The avowal I think it far more creditable to his candour than to his generosity, gentlemanly feeling, or sympathy for a brother inventor.

WHARNCLIFFE SILKSTONE.

COAL-CUTTING MACHINERY.

Sir,—Mr. Rothery, of Waterloo Colliery, near Leeds, has written to the Journal frequently. He is an interested "judge;" I have not found in any of his letters an approving or encouraging word for the inventor of any coal-cutting machine. I should have expected that the gentle reproof of last week from "Wharncliffe Silkstone" Collieries would have operated upon his envious spirit; but it is not so, for he returns "like a dog to its vomit," and again unscrupulously attempts to injure Mr. Hurd, who appears to have acted in a perfectly open and gentlemanly manner throughout. All your readers, with, perhaps, the exception of Mr. Rothery, desire the success of coal-cutting inventors. At all events, they may set it down that the more virulent Mr. Rothery's attacks may be upon any new machine the greater are its merits. A CONSTANT READER.

Durham, Dec. 7.

COAL-CUTTING MACHINERY.

Sir,—A correspondent who occupies a large space in your valuable Journal makes the following statement in the last number:—"I am an inventor of coal-cutting machinery from the date of the introduction of the pick machine." He does not state his own age, and, therefore, there is some uncertainty upon that point; but there is some evidence in the "Blue Books" which enables us to judge as to *the date of the introduction of the pick machine*, which was in 1761, or 109 years ago. In that year a Mr. Menzies, of Newcastle-on-Tyne, obtained a patent for getting coal by machinery, and in his claim he says:— . . . "By means of a wheel a chain is turned round in the board, to which a heavy pick is attached."

I make no comments upon these passages extracted from documents, as they speak for themselves. VINDEX.

ILLUMINATION OF MINES.

Sir,—The complaint of the large number of lives annually sacrificed in collieries through explosion is so constantly made in the *Mining Journal*, that I feel I need make no excuse for offering a few remarks upon so important a point in connection with colliery explosions as the illumination of mines. The innumerable efforts to provide a really reliable safety-lamp when oil is burnt have hitherto all resulted in failure, and electricity appears to be the only agent likely to give us any better result. So much progress has been made in the economic generation of electricity during the last few years, that it seems to me probable that propositions which were once quite useless might now perhaps be turned to practical account; the application of electricity to the illumination of mines would now, I believe, be quite practicable. At the recent meeting of the British Association, a paper on the generation of electricity was read by Mr. Highton, from which I concluded that he could generate electricity in almost any quantity at a merely nominal cost.

Now, with an abundant supply of cheap electricity, there seems no reason why such a lamp as the Dumas and Benoit should not be generally introduced in collieries, and if this were done, concurrently with the expulsion of blasting in collieries containing fire-damp, I believe that the occurrence of an explosion in a coal mine would only be known as a matter of history. As the principle of the electric lamp as proposed for mines may not be known to all your readers, it may be well to add that the ignition of explosive gas by such a lamp is impossible. The light is emitted from a Geisler tube, the negative and positive electricity reaching each other through the tube, from which the air has been exhausted. Of course the flame cannot get out of the tube whilst the tube remains perfect, and if the tube be not perfect the flame cannot exist at all. The objection to the lamp is that it gives a very small amount of light, but if the cost of electricity were merely nominal instead of very great, as it was when the lamp was originally tried, I should think the difficulty might be overcome by using three or four tubes side by side. These, however, are little details, which would, no doubt, be easily dealt with after more experience has been gained, the great point being the price at which the electricity could be generated.

As I am not connected with electrical matters myself beyond occasionally sending a postal telegram, I may be allowed to ask certain information from electricians, which I think necessary to permit of an opinion being formed as to the probable relative cost of electricity, and the present system of illuminating mines. I do not know whether Mr. Highton, or any other electrician, has ever ascertained the cost of obtaining a light in (say) 500 Geisler tubes, 6 in., long simultaneously, but if Mr. Highton could state this I think we should have some basis to start from. I should further like to know whether each tube would require a distinct wire from the generator, or whether a main and numerous branch wires would be sufficient. I saw the lamp at a soiree given by one of the scientific societies, I forget which, some years since; but when told that the lamps were 7*l.* each, and that each required a separate battery, I gave up the hope of using it in a colliery. Matters, however, seem now to have changed, and I

should be glad to lend my aid to facilitate the introduction of such a perfectly safe system of lighting. COAL.

Wigan, Dec. 5.

RUSSIAN IRON MANUFACTURE.

SIR,—English ironmasters should congratulate themselves that the necessity for railways in Russia was felt and seen at a time when the iron industry of that empire had not recovered the shock it had experienced from the improvidence and bad management of its owners and administrators, and, consequently, was not in a position to do anything towards supplying the new cause of demand that arose. Let us see if this position is likely to remain, or whether a great change must not be expected.

The iron industry of Russia, taken 50 or 60 years ago, was a very respectable one, but it so rapidly fell off, from various causes, the principal of which were the extravagance of the proprietors of the private works and mines, and the incompetent and dishonest management of the Government employees, that when the empire began to reform itself, and move ahead, by building railways, the iron trade was much worse than it was half a century before, and all orders for rails went to the foreigners.

The Russians are not an initiative people; and although for many years the wealth of Russia had been well known as regards her iron-producing power, it was in those days felt by foreigners that it was not a safe country to invest capital in, and, consequently, they were not attracted by the apparent advantages into building works and increasing the production.

The statistics of Russia were at the time I am now speaking of little to be depended upon; and it is somewhat difficult to arrive at the quantity of iron which that country did produce, but it is quite certain that the quantity made had very considerably decreased. The waste of fuel contributed something to this result, as the woods were cut down without any order or regularity, and immense quantities thus destroyed. Since, however, the rapid advance of railways, and the great demand for rails, has proved to the Russians what an immense amount of profit they have lost by hitherto neglecting this branch of industry, every pains and attention have been given to the subject; and the Government itself, through its present able Minister of Finance, M. de Reutern, has come to the rescue of the question. The result has been that during the last few years the quantity has been increased, and the manufacture very considerably improved. The quantity we take for the moment to be the most important side of the question, and the one most interesting to English ironmasters.

It is now, also, difficult to arrive at the quantity manufactured, but if we put it at about 210,000 tons annually it will be near the mark; this, however, is not nearly sufficient for the ordinary wants of Russia, leaving alone the question of the quantity required for railway purposes, and inasmuch as Russia, progressing in civilisation as she daily is, requires more iron, it follows that the production must be much increased before she can expect to supply herself. Our object is to show, however, that the supply can be much increased, and that most materially. Necessarily we must look to coal to produce iron in sufficient quantities for the supply of such a gigantic empire as Russia, but even with charcoal she can do wonders. At several spots in Russia, notably in the Ural Mountains, pig-iron of the best quality, made with charcoal, can be produced for 1*l.* 11s. 6d. a ton; and, inconvenient as the means of transit are from this rather distant country, the same iron could be brought down to the centre of Russia—Nishny Novgorod—for 1*l.* 5s. per ton, thus costing there 2*l.* 16s. 6d., and, adding a profit of 20 per cent., could be sold at 3*l.* 10s. 6d. per ton English pig, therefore, at 2*l.* 10s. in Scotland, cannot compete with it. In many places pig is produced for 2*l.* 7s. 6d. per ton, and, therefore, were the make increased English iron would be knocked out of the market, excepting at those points of consumption close to the ports. But the fact is that it does not pay the producers to sell their iron in pig; they can do much better with it by making it into merchant iron. Bars can be manufactured for 6*l.* 13s. 9d. a ton. How can English makers compete with this? Rough castings, such as pots and pans, at 7*l.* 17s. 6d., surely can hold their own against any competion. Necessarily at the moment, as the production is so far behind the consumption, the question of competition does not arise, as the manufacturers are enabled to sell at prices which give an immense profit, and, therefore, do not require to compete. We know one establishment, and that a very large one, where the profit is 180 per cent. on the quantity of iron turned out in the year.

To speak of rails, they can be manufactured to-day for 7*l.* 2s. per ton, but of course a manufacturer will prefer making his iron into smaller sorts, upon which he can realize far larger profits. We mention these facts in passing not so much as affecting the object we have in view to-day—to show that the production can be increased—but to show why, in the article of rails, no competition has been tried. At present rails are made at two works in the North and Centre of Russia, at the Tagil group in the former country, and by Mr. Poutileff in St. Petersburg; the former turned out last year 9500 tons, and the latter can roll 30,000 tons in a year. The owner of the Tagil works, Mr. Demidoff, sells his make at 11*l.* 16s. 2d., delivered at Moscow; certainly not so profitable a business for him as if he were to make other iron, but patriotic views no doubt guided him in entering upon this branch of manufacture; but even this price for charcoal-made rails does very nearly compete with foreign made coal ones, when the value of the old rails is taken into consideration, as the old charcoal rails will fetch nearly double the price which the old coal rails do. It is impossible to estimate the quantity of iron in Russia, or to speak of the extraordinary facilities which it presents to the worker. We have only to mention the famous mountain of Blagodat, a mass of magnetic ironstone, yielding 68 to 70 per cent., and coupling with this the other immense deposits of similar ore at Tagil, Ufaleeh, and in the Altai Mountains, and to think that all these inexhaustible deposits are simply quarried out, to show a supply of iron for Russia for centuries to come far in excess of any possible wants. The other parts of the empire producing iron are far too numerous to mention here. Suffice it to say that over a large proportion of the empire iron ore of all descriptions, from magnetic to red oxide, is found.

There are still vast forests untouched by the axe growing alongside and upon these untold riches, in places where iron can be manufactured in far larger quantities than has ever been attempted before, where labour is abundant, and consequently cheap, and where, although the means of communication are not of the best sort, the mighty water system of the empire permits the means of delivery at the places of consumption. For any amount of iron which Russia can possibly want for its own ordinary purposes we consider its forests can furnish sufficient fuel to manufacture, and that at a price which no foreigner can compete with it even at its own ports.

At present there is a protective duty, the reason for which cannot be understood. Iron is produced more or less in most parts of Russia; therefore, distance is its best protection, and no tariff is required to protect the Russian producer against the English.

The protectionist party, at the time the tariff was undergoing revision, took particular pains to insist on the import of iron being taxed. This may have been, in a great measure, owing to the fact that the head and most active person in this retrograde movement was an ironmaster. The party had not the sense to see that even as manufacturers they would be benefited by free trade, that the cheaper iron could be imported the more it would be consumed, and that by such increased consumption the demand would go on increasing, and that in such a multiplied form as would have enabled them eventually to have profited by the free importation. They failed to see that one reason why their own trade in the article had fallen off was this very question of protection, not only in the shape of an import duty, but also in the very illogical one of an excise tax, as until the late revision in the tariff the excise tax was 4s. per ton, now reduced to 2s. 6d., to equalise the revision on the import. Had this party, on the contrary, advocated the remission of the import duty the excise tax would have, of course, been taken off also, the whole of which the producer would have kept in his own pocket. The consequence is that at present cast-iron in pig pays a duty of 8s. 6d. per ton; bar iron, 2*l.* 17s. 10d.; and rails, 1*l.* 13s. 1d., whilst the Russian producer still has to pay 2s. 6d. a ton on all pig-iron he makes.

For rail purposes we must, however, look to coal to come to our assistance. And surely coal exists, and exists in masses. At this present moment the great discovery on the banks of the Kama is laying practically untouched; there is the coal, and there is the ironstone beside it, and there look on the workmen ready and willing to work it out; there may be seen a deposit wanting nothing but a pick to work it out and a cart to put it into; but, no; at present nobody has the pluck to begin. We are not exaggerating in saying that in this one spot alone might be made enough rails to go far in providing the Northern and Central parts of Russia with rails.

Turn again to the Don basin, there is coal and iron beside it to satisfy the most greedy consumer, only waiting to be developed and made useful. Look once more on the anthracite further south, and who can deny that Russia has within herself the means of satisfying all her wants for her iron ways.

Labour is abundant and cheap; a shilling a day is not extravagant pay. Given, therefore, every requisite required—the iron, the fuel, the labour—all at a minimum, and we think it must be be admitted that the day cannot be far off when not only will no English ironmaster be able to compete with a Russian one on his own ground, but possibly the tables will be turned, and the Russians will be able to compete on some of those markets which at present our countrymen are used to consider as their own.

In conclusion, we can only add that the moment is the one in which to look for the impetus in the iron trade of Russia which we predict will arise. Mr. Reutern, in his patriotic zeal for the welfare and progress of his country, has come to the decision to advise the transfer of all the Government works to private enterprise; this carried out, and we may expect to see that advancement in the iron industry of Russia which the circumstances warrant. The productive power of Russia is great, so great that when pursuing the path of wise reform which she has chalked out for herself during the last few years she shall have arrived to that pinnacle for which she is striving, she will hold in her hands a destiny to be wielded for weal or woe that in the history of nations has, probably, never been equalled.

Union-grove, Clapham. HERBERT BARRY.

UTILISATION OF SLAG.

SIR,—Reference was some time since made in the *Mining Journal* to the utilisation, by Messrs. Sepulchre and Ohresser, of Brussels, of blast-furnace slags as a substitute for granite chips for the macadamisation of roads, but although I have since used great endeavours to ascertain the success of the trial I have been unable to procure any details whatever, and cannot even learn the precise address of the proprietors of the process of applying it. From the abundance of slag at present lying waste about our ironworks, it would be of great importance if some ready means of using it could be found, as it would materially add to the ironmasters' profits, not only by enabling them to get rid of a useless material, but by relieving them of the trouble of providing for the stowage of so much rubbish.

The cost of carriage from the works would, no doubt, be the chief item of expense; and I should, therefore, be glad to learn the price at which slag could be delivered in London. In this estimate I think it would be better to state the price per cubic yard than the price per ton, as, if it were delivered in too small pieces, the extent of roadway which a 100 tons would cover would be very small as compared with what would be covered were the size about equal to that of granite chips. With regard to the mode of metalling a road, it is observed that it is not satisfactory to lay slag in the same way as granite, because the slag, being more brittle, grinds itself to pieces before it can get properly run in; and it has been suggested to me that the best way to secure the introduction of slag as a road material would be to devise some means of forming it into a conglomerate when laid by the use of some suitable cement.

As to what cement would be applicable I do not know, but if some thing could be found that would hold the slag in position, and thus prevent abrasion, I can quite understand that the durability of a slag road would be very great. I was informed that slag was offered as a road material to one of the parish vestries in Southwark or Lambeth at a considerable reduction upon the price of granite chips, and that it was stated that no charge whatever should be made if it did not keep the road in good repair more cheaply than the granite by some large percentage, which was mentioned; yet it was not tested, and we have thus no means of knowing whether it would be as desiderable to use it in this country as in has been found in Brussels and Paris.—*Dec.* 6. S. O.

DYNAMITE.

SIR,—Your correspondent, "Iron Ore Proprietor," enquires whether it is lawful to use Dynamite, or whether it is a prohibited explosive, and whether it is subject to the same restrictions with respect to its carriage from place to place as nitro-glycerine?

I beg, in reply, to inform him, and all others interested in the subject, that it is lawful to use Dynamite, and that it is not subject to the same restrictions with regard to carriage from place to place as nitro-glycerine, inasmuch as it is not included within the provisions of "The Carriage and Deposit of Dangerous Goods Act, 1866," which applies solely to the carriage and deposit of nitro-glycerine. There is, however, another Act of Parliament, which was passed in 1869, rendering it necessary to obtain a licence from one of Her Majesty's principal Secretaries of State to import or export nitro-glycerine, or to manufacture, sell, carry, or possess nitro-glycerine before doing so; and, inasmuch as the Act declares that its provisions shall extend to every substance having nitro-glycerine as one of its component parts, which Dynamite has, all persons who desire to use Dynamite should apply to the Home Secretary for a licence to store it. Such licences are granted on application, free of charge, and have never been refused.

I have good reason to believe that certain parties interested under patents in the manufacture of gun-cotton imposed upon the Home Secretary, and induced him so to word the Act of Parliament as to include Dynamite in its provisions, but that he is now satisfied he was misled, and that it is, in fact, much safer to use, store, and carry than gunpowder or gun-cotton. No accident has hitherto occurred from its carriage, storage, or use in mines. The Act, according to its title, was only intended to remain in operation for a limited period, and I believe that it is likely to be repealed shortly.

It is preposterous that any impediment should be thrown in the way of miners using Dynamite, which is rapidly superseding the use of gunpowder in Germany, and that no restriction whatever should be applied to gun-cotton, which is really more dangerous, and not so valuable for mining purposes, being useless in wet ground. A fearful accident from the explosion of gun-cotton from spontaneous combustion is reported to have lately taken place at Alexandria.

Your correspondent further enquires if the representation which has been made to him, that Dynamite "is a much more effective agent than gunpowder, and can be used with greater effect and safety in wet holes, where the ground is full of loughs, or vughs, as they are called in Cornwall," is true, and asks for evidence of practical men who have seen it. In answer to this, I can assure him that such is the case. I have constantly fired it with the best effect in wet holes, and under water. It is now being used in the Mellanear Mine, and at Wheal Uny, Redruth, and no doubt the experienced managers of those mines must be abundantly satisfied with the advantages attend- its use, or they would not use it and speak of it as they do. It has also been used at Bantry and Galway harbours, for blasting rock in wet ground, and under water. One of the best and most accurate descriptions which I have seen of the advantages and safety of Dynamite appeared in a letter in the Supplement to the *Times* of Oct. 31 last, from Mr. Henry Conybeare, on the siege of Paris; and I consider this testimony of its value and safety the more satisfactory, as coming from a stranger, uninterested in its manufacture or sale.

Carnarvon, Dec. 6. O. W.

PRINCE OF WALES MINE.

SIR,—In last week's Journal appears a letter from a shareholder, complaining in unmeasured terms of the supineness of the executive and Capt. Gifford for not having made a trial of the tin, which, according to the statements of Captain Pryor at the meeting, is very abundant in this mine. As a third party is called in I will not prejudge, but advise your correspondent that it would have been wiser to wait the result of the assay before indulging in so much censure. The value of the discovery at New Great Consols remains to be tested. Returns are not profits, or the immense returns of copper and mundic hitherto made from this mine would not have resulted in such heavy losses to the shareholders and the creditors.

Waiting the result of the assay, I desire again to call the attention of my fellow-shareholders to what I not only call supineness, but a breach of faith on the part of the executive of our mine. I allude to their neglect of the silver lode passing through the sett, and on which it was stated, some months since, "operations were to be commenced immediately." The nearness of the "Queen" workings to the boundary, coupled with the fact of sufficient silver ore having been raised to enable the company to declare a dividend since the promise referred to was made, certainly ought to have led to something being done; and if the reports I hear are true—that the directors of the "Queen" have freely offered the use of their shafts, materials, &c., for the trial—there is less excuse for the omission. It is not matter of surprise that the shares are quoted only a few shillings each when the interests of the shareholders are neglected by abstaining from prosecuting a valuable discovery when the opportunity of doing so is offered gratuitously. With the large balance in hand, I hope to see operations commenced on this lode at once. This is my third letter on this subject, and I hope further application for your valuable space may be unnecessary.

London, Dec. 7. LAX.

THE DISCOVERY OF TIN IN NEW GREAT CONSOLS AND PRINCE OF WALES MINES.

HONOUR TO WHOM HONOUR IS DUE.

SIR,—If the letter which appeared in last week's Journal upon this most important subject possesses no other merit, it is perfect in its inconclusiveness. It is properly enough headed by the truism that "honour should be accorded to whom honour is due," but in this case your correspondent would have us believe that the merit of this discovery at New Great Consols is due to "an official connected with the Duchy of Cornwall," *because* he "prohibited the sale of the coppery mundics, on account of their value being greater for tin." Of course, but one enquiry can arise out of this extraordinary admission. How is it that this lynx-eyed official did not issue his prohibitive fiat until 1870? Either this "official," whoever he may be, did not before know that these "coppery mundics" were rich for tin; if he did he has scarcely been a faithful servant in allowing it to be sold for one metal when he knew it was more valuable for another.

But how does the case stand in regard to the Prince of Wales Mine? Here the same official could exercise the same power, the property belonging to the Duchy of Cornwall. I presume the answer would be that at this mine the mundic lode is not being wrought; but Capt. Richard Pryor told us at the meeting that months since he had taken several samples from different parts of the mine, *the whole of which produced tin!* Where is this prohibitive official? Nay, what is the value of the opinion of our own agents? Our Chairman frankly told us at the meeting that both Mr. Jehu Hitchins and Capt. Gifford pooh-poohed the idea of tin being found in our mundic, although Capt. Richard Pryor pointed out the fact some months previously; and it was this pooh-poohing (said our Chairman) that induced the committee to remain inactive in the matter. Seeing that Capt. Pryor has had (and still has) to contend against the obduracy of the "practical men in the district"—as your correspondent terms them—and yet is making astounding progress at his own mine—the New Great Consols—I most fully agree with "An Observer" that "honour should be given to whom honour is due."—*Dec.* 6. JUSTICE.

CARN BREA MINES.

SIR,—A few weeks since it was announced in various papers that this mine had a debt upon it of 15,000*l.* This is evidently wrong, as shown by the statement sent to the shareholders by order of the directors, through the purser, Mr. R. H. Pike, and dated Nov. 21, which shows the financial position of the mine to be in a very healthy state. The labour cost, bills, whim-engine, lord's dues, London management, discount, interest, and travelling expenses, for eight months ending August amount to 27,777*l.* 4s. 9d., while the credit to same date (a very unusual thing to see) is 30,883*l.* 3s. 10d., showing a profit upon the eight months of 3105*l.* 19s. 1d., and a credit balance of 547*l.* 0s. 10d. Are there many other mines in the county can show so clean a bill of health, with every item charged up to the day of credits? Questionable, notwithstanding bi-monthly and quarterly dividends are regularly declared, even if they have to credit tin on account, or overdraw the banking account, and pay interest for advances made to pay dividends. Carn Brea has set a noble example to all other mines. Let the secretaries and pursers of other mines in this county follow this example, whether dividend or calling mines, by charging up all debits to the day of credits. We should not then find the Stannaries Court so over-crowded with petitions to wind up, and in the winding-up process have to make such heavy calls as in the case of Sithney Carnmeal and Wendron Consols, had the liabilities of these mines been charged up as in Carn Brea.

Dec. 6. A SHAREHOLDER IN VARIOUS MINES.

EAST SETON.

SIR,—My attention has just been drawn to Mr. Treherne's letter in the Journal, asking if the advance of salaries at the last meeting was unanimous. Doubtless it was. There were about ten persons present, five of them officials of the mine, and four of them participators in the advances. The proposer was the urgeon of the mine, a holder of five shares, and the seconder a chain and kibble maker, living near the mine, and, I believe, a holder of five shares also; about 200 shares represented this meeting, independent of the purser's 700, and those he held proxies for. Be it known that on almost all occasions the purser has proxies for fully half the mine; whether they are renewed for every meeting I cannot say, as there has not been one occasion to scrutinise them, and I have attended all the meetings but the last and a former one. The advance to the purser was attempted at the previous meeting, but opposed by myself and two other shareholders—one a holder of 10 shares, the other, I believe, 50, and the representative of 1100 more. Now, will it be believed that under the guise of economy this very generous and economising purser will not allow a dinner to be provided for the adventurers on the account days, neither will he allow the agents any on pay-days, yet until recently he has charged 21s. travelling expenses fo each account and pay-day, and had 7*l.* 7s. per month. As this has been disallowed, he now comes and asks (through others) for 36 guineas a year extra, making his salary 120 guineas per annum. For what? about two days' work per week, as the clerk, Mr. Reynolds, makes up all the books—in fact, does nearly all the work, except registering transfers, and would, no doubt, do the whole for 6*l.* 6s. per month. If he would not there are those who will, and quite as efficiently (better is impossible): 25 guineas a month, more than one-eighth part of the entire cost, including engine cost, cannot be considered proper. It is asked, cannot this be rescinded at the next account? Doubtless it can, but not if shareholders are so unwise as to entrust a person with their proxies who hold such a very heavy interest, and whose interest it is to confirm the resolutions of the last meeting. It has already been hinted by letter unless the shareholders take care the same will be done by this as in other mines—appoint a London office, secretary, and committee, and saddle the mine with a call far above the paltry advance of 3*l.* 3s. per month. The sett is a good one, perhaps the best of the whole of the Setons, and if the operations had been continued vigorously about Cartwright's, it is questionable if the mine would not now about pay the cost. This valuable part of the sett has been nearly idle during the summer months now the wet season has set in Cartwright's shaft has resumed sinking. Who is the director? I do not believe the manager is.

Dec. 6. A SHAREHOLDER FOR YEARS.

THE PEN'ALLT MINING COMPANY.

SIR,—By reading last week's Journal I was much pleased to find that the Pen'Allt meeting, held on the mine, passed off so satisfactorily, to the great delight of the proprietors, also very pleasing to their respected agent, Capt. Glanville. Such ought to be the case throughout the mining world—I mean that meetings should be held on the mine at least twice a year; it would bring the shareholders and agents together. They could then judge of each other, and, although sometimes we may fail, yet in the long run a man is better judged from personal intercommunication. Let us take, for instance, mines of the present day. Look over the Journal; take a trip through the mines so highly reported upon, and then judge for yourself. Your expenses of the journey will not be thrown away, although it may cost a trifle to go through the undertaking, yet in the end you can prevent your friends and self from spending thousands that would, without the journey, have been perhaps lost. Gentlemen, speculators, try this plan, you may rely upon success. I know that agents throughout the kingdom are at all times glad to see the proprietors on the mine; it encourages them, and puts new life into one, when, knowing well he is doing his duty, yet fearing the frown of no man. I would, therefore, advise any and every shareholder to go or send some one on whom they can rely to learn the real facts.

There is also a letter of Mr. Sewell's, from Spain, who, touching upon mineral property, says that since the alteration of grants of mining setts to different parties mining is getting more general, and that by seeing the engineers busy erecting machinery they may shortly expect to see the country throughout flourishing in mineral products. May his desire be verified.

I have not had time for the past few days to visit the mines, as I thought of doing, but hope shortly to accomplish the fulfilling of my promise. The weather in this part of the county is very mild, free from frost, and all unhealthy fogs, &c. Consequently dressing in all its branches is going on very comfortably, where the machinery does not predominate over mineral and stuff for the market.

West Bronfloyd Mine, Aberystwith, Dec. 6. S. TREVETHAN.

A WORD ON NORTH ROSKEAR MINE.

SIR,—The mine is divided into 695 shares, more than half of which belong to an individual or estate represented by Mr. Fletcher, the accountant, of Old Broad-street. That gentleman has made up his mind to transfer the whole management of the mine from London to Cornwall, with or without the consent of the other shareholders. Among other motions proposed by him at the general meeting held at the London office, on Nov. 30, with a view to carry out the above intention, the following was submitted to the Chairman:—"That Mr. Thomas Pryor, of Redruth, be, and is hereby, appointed purser of the mine, at a salary of nine guineas per month." This motion, as well as all those relating to the transfer of the management, was put by Mr. Fletcher, and, in every instance, seconded by Mr. Thomas Pryor—*i. e.* (no shareholder present being willing to do so), Mr. Pryor seconded his own appointment to the office of purser. It is satisfactory to add that Mr. Milford, the Chairman, refused to assist in this act, by putting the resolution so seconded to the meeting.

AN INDIGNANT SHAREHOLDER.

THE NEW QUEBRADA COMPANY.

SIR,—In last week's Journal appears a letter from Mr. Frederick H. Hemming, wherein he three times refers to the late meeting of the shareholders of this company as being an "illegal" meeting. We are instructed by the board of directors to contradict such statement, and to say that there is no ground whatever for it, and that the meeting was perfectly legal. G. L. P. EYRE AND CO.

1, *John-street, Bedford-row, London, W.C., Dec.* 8.

[For remainder of Original Correspondence see to-day's Journal.]

PRODUCING PRUSSIATES.—The invention of Mr. P. SPENCE, Manchester, relates to the production of prussiates of potash, prussiates of soda, and prussian blue. The inventor has found that when the oxides or other compounds of iron have become spent they contain, in addition to ammonia and sulphur, a quantity of ferro-prussic acid or ferro-prussiate of iron, and he proceeds to produce from them prussiates of potash and soda and prussian blue. When the spent substances contain salts of ammonia they are washed out in any usual manner, and the matters are in that case ready for the above named purposes. Where the matters have no considerable amount of ammonia salts, the invento

takes them as they come from the gasworks. He proposes to grind these matters and to place them in a suitable tank, with a false bottom provided with small spaces, and then to run hot water over them until the soluble substances are washed away, after which, if the object be to obtain prussiate of soda or prussian blue, he treats the matters with a hot solution of carbonate of soda, and subsequently boils down, if prussiate of soda be required. For prussian blue the inventor precipitates by iron salts, as is well understood. For prussiate of potash he uses carbonate of potash, which he prefers to be pure and not containing caustic potash. The aforesaid matters having been treated with this, the liquor is boiled down, and the resulting crystals may be re-crystallised, and prussiate of potash of commerce is thus obtained.

A PROGRESSIVE SERIES OF POPULAR LECTURES ON GEOLOGY.—Lecture VII.

Our readers may remember that in the last lecture we finished with the igneous rocks, and gave some account of the origin and nature of earthquakes. The work before us now is to consider the metamorphic or stratified crystalline rocks. This term (derived from the two Greek words *meta* and *morphe*, corresponding to the Latin *trans* and *forma*) was originally proposed by Sir C. Lyell, in the year 1833; and under it were included all rocks that have been altered, whether by heat alone, or by heat and water, from their original condition. The origin of these rocks is more doubtful than that of the aqueous or igneous classes—they contain no pebbles or sand, they are devoid of all traces of organic remains, they are as often crystalline as granite, and yet are divided into beds and layers, corresponding in form and arrangement with those of sedimentary formations, and hence they are called *stratified* crystalline rocks. The beds often consist of an alternation of substances varying in colour, composition, and thickness, which is precisely what we found when considering the formation of the aqueous or stratified rocks. We may, therefore, assume that the materials of these strata were originally carried down and deposited by water in the usual form of sediment, and that they were subsequently so altered by subterranean heat as to obtain a new and totally different texture. This assumption is not altogether groundless, for in some cases it may be seen that such a complete conversion has taken place from the contact of stratified rocks with granite. Dark limestones, full of shells and corals, have been turned into white statuary marble, and hard clays into various kinds of slates. We are still ignorant of the precise nature of the influence exerted in these cases, yet the results are clearly analogous to those produced by volcanic heat and gases; and the action may be conveniently called plutonic, because it appears to have been developed in those regions where plutonic rocks are generated, and under similar circumstances of pressure and depth in the earth. This plutonic influence may have been assisted by hot water or steam permeating the stratified masses; but we are inclined to believe that by far the greater portion of the work has been done by direct plutonic agency. Indeed, the supposition amounts almost to a certainty when we reflect that these metamorphic rocks *only* occur in connection with and adjacent to masses of granite or other plutonic rocks, and that their extent is always proportioned to the particular mass of granite round which they occur. The presence or absence of steam or hot water would be one of the modifying causes rather than the chief agency, producing, perhaps, some of the many varieties which occur among a mass of metamorphic rocks. These varieties, however, are mainly due to the different materials, or the different proportions of the same materials, which existed in the stratified beds previously to the application of the plutonic agency. Having obtained this general idea of metamorphic action, we may now proceed to consider the rocks themselves. The metamorphic rocks may be divided into two sub-groups—those in which the original mineral structure is still recognisable (the particles not having entered into new combinations, however they may have been altered in form and state), and those in which such new combinations have been produced.

Those rocks in which no new combination has taken place are of three kinds—siliceous or sandy, argillaceous or clayey, and calcareous. The rocks of the sub-group, or those in which new combinations have taken place, are known as the *schistose rocks*. *Quartz rock*, or *quartzite*, is the only variety of the siliceous class. It may be best described by calling it a semi-crystalline sandstone, fine grained, but distinctly granular, very hard and often brittle. A perfect passage may be traced from sandstone into quartz rock, the rock becoming gradually more and more crystalline in its character. The sandstones used for the hearths of furnaces are often converted into quartz rock, an additional proof, if any were needed, that the metamorphose is produced by heat. This quartz rock must be carefully distinguished from *vein quartz*, so common in Australia, which is not an altered sandstone contemporaneous with the rocks in which it lies, but a deposition, in a vein or fissure, produced subsequently to the consolidation of the rocks it traverses.

Of the argillaceous or clayey kinds there are two varieties. *Porcellanite*, or *hornstone*, is the name given to a clay or shale which has been converted into a smooth, hard, brittle, and splintery rock, by contact with a large mass of greenstone. It is often found in places where igneous rocks have burst through, and baked clayey strata. *Clay-slate* is the other variety, and is simply shale altered by pressure and heat. It has the peculiarity of splitting into plates that are altogether independent of the original bedding of the rock. The original lamination, however, may frequently be traced, even in hand specimens, by the lines, or bands, of different colour which traverse the rock, and which have been called by Prof. Sedgwick the *stripe* of the slate.

There are three principal varieties of the calcareous metamorphic rocks—crystalline limestone or statuary marble, dolomite, and serpentine rock. Some limestones were originally formed as crystalline limestones, just as many parts of a coral reef, and some stalactites are crystalline internally; but the majority have assumed the crystalline structure at a period subsequent to their formation. The well-known experiments of Sir James Hall go to prove that the crystalline structure was brought about by heat. He showed that even chalk could be converted into a hard crystalline marble by being subjected to heat under a pressure that prevented the escape of the carbonic acid gas. This beautiful rock, called *saccharine* or statuary marble, is a white, fine-grained rock, resembling loaf sugar in colour and texture; it is not liable to splinter, and may be worked freely in any direction, which renders it so valuable to the sculptor, especially as when the work is complete it is capable of taking a polish; and the fact of its being also slightly translucent adds much to its beauty, and gives life to the statue, otherwise cold and dead. There are other varieties of altered limestone variously coloured, and more or less coarsely crystalline.

Dolomite is often metamorphic, though we meet with it also in large quantities as an original formation, when it is more generally known as magnesian limestone, certain qualities of which are so useful for building purposes. The metamorphic dolomites are generally perfectly crystalline, either in large or small granules, and very often porous in texture, so that the crystalline granules may be seen to touch each other at only a few points. As an example of this metamorphism, we may mention the fact that the basalt of the Giant's Causeway, in Ireland, has converted the chalk on which it lies into dolomite. The so-called *serpentine rock* is often nothing but a highly metamorphised dolomite, and serpentines have been traced in Canada until they have gradually passed into beds of unaltered magnesian limestone. Serpentine, however, may also be the result of the metamorphism of the hornblendic rocks, which, it will be remembered, contained a considerable proportion of silicate of magnesia.

We pass on now to the second sub-group of the metamorphic rocks, known as the *schistose rocks*, in which, besides the crystalline structure induced by metamorphism, a further change has taken place. This further change, known as *foliation*, is one of a most remarkable character, and consists in a separation of the component minerals out of the body of the rock, and in their re-arrangement, each in distinct *layers* or *folia*. Thus, *gneiss*, the chief variety of this species of rock, is exactly like granite, except that its components (felspar, mica, and quartz) are arranged in separate layers or folia, instead of being all mixed up as they are in granite. *Mica schist*, another variety, consists of alternate folia of mica and quartz, or of clay-slate and mica. These rocks are metamorphosed micaceous sandstone and shale, and mica schist is often only distinguishable from gneiss by the small flakes of felspar which may be detected in the latter. It has been remarked that metamorphic rocks are void of all organic remains; this is not always the case. The intense heat to which the original rocks must have been subjected has generally been sufficient to completely obliterate all the fossils. Sometimes, however, they are only partially effaced, and we may occasionally meet with them as perfect as ever.

We have now completed what may be called the first great division of our subject, and here for awhile we would allow it, our readers, and ourselves to rest—at least, from the arduous task of geological research. In these stirring times rest in the abstract must be a thing unknown. Metamorphisms of the most rapid, complete, and wonderful character are taking place before our very eyes, and we look for disturbances not less real, and perhaps more violent, than the earthquake and volcanic eruption. Indeed, it would seem that the alarm bell had already been sounded, and that we are just waiting for the shock—hoping, perhaps, at the same time that the alarm after all may be false. Be this as it may, stress of other engagements, not disconnected with the subjects above alluded to, will prevent the publication of the rest of this series until the ensuing February, when it is to be hoped that they may be continued. They will embrace a variety of subjects, information on which may be useful to some of our readers, such as the "Qualities of Various Rocks for Building Purposes," "The Origin and Nature of Water Supply," "The Connection between Scenery and Geology," &c.

OUR FUTURE COAL SUPPLY—CANNOCK CHASE.

THE IRON KINGS, THEIR DUSKY REALMS, &c.

BY J. RANDALL, F.G.S.

There yet remains a portion of the legitimate inheritance of the Iron Kings which is neither dark nor dusky, one which welcomes you with a fresh and bracing air, and which in places presents no sign even of human habitation, far as the eye can reach. There is the golden gorse, the graceful fern, the lady birch, and hardy larch; but with the exception of these the surface is the same as when it rose above the waves which grooved it into its present valleys, which yet retain heaps of ancient shingle, the waste of pebble beds themselves the shingle of still more ancient Triassic seas. I allude, of course, to to the extreme northern end of the coal field on Cannock Chase, to that portion of it where there are as yet no indications of works of any kind, which still retains its characteristic look of primitive wildness, and is not even enclosed. Indications are not wanting, however, to show that it is destined not long to remain in its present state. Commissioners have been sent down to Rugeley to enquire respecting certain prescriptive rights claimed by the inhabitants; and cottagers from the common, in costumes of other days, with white locks and long staffs, have attended to give such evidence as usually carries weight when coming from old inhabitants, with a view to its enclosure. But coveted as the surface may be, and whether enclosed or not, this long stretch of tableland possesses a value beyond that which the cultivation of the soil can give, and such as will cause it ere long to be stripped of its covering, in order that it may disclose that large amount of virgin wealth which the interests of the district demand to balance the deficiencies of the exhausted southern portion of the field; not, indeed, that those possessing manorial or other rights are ignorant of the value of the subterranean treasures stored for future use, or that they are unwilling they should be turned to account, for the large slices which the Marquis of Anglesea has already leased have shown that he can turn his "kitchen garden," as this beautiful desert has been called, to better account than by growing furze as a covert for game. Indeed the noble Marquis, and Lord Hatherton too, are becoming fully alive to the value of their property for mining purposes; whilst the Cannock Chase Colliery Company, the Cannock and Rugeley Company, and a company still more recently formed, who are now carrying down their new shaft, are evidencing the faith they have in this rich mineral tract by their works. Nor does there seem at present any good reason why speculators in this undeveloped portion of the field should confine their researches within limits which have too hastily been deemed its boundary lines, or why the valuable minerals the district contains should not be followed as far as the thickness of the overlying covering of Red Sandstone will allow, or the absence of any evidence of denudation may permit, and that in the direction of North Staffordshire, of Leicestershire, or of Warwickshire.

So far as I am aware, the boundary lines of the Cannock Chase district, as at present ascertained, are lines of dislocation, which have merely thrown down the measures on the outside, but evidently—as shown by the poverty of the overlying red rocks themselves—to no very great depth. Nature, although in some instances apparently wasteful of her treasures, has here done much towards making her wealth available, by shaving off and planing down the superincumbent New Red Sandstone covering—leaving heaps of chips, in the form of pebbles, to show the vast extent of her work. The soft Upper Red and Mottled Sandstones of the Keuper—those formidable barriers south-west, from their great thickness—have been stripped off entirely; whilst the harder conglomerates of the Bunter remain, to form the lofty table-land of the Chase. In some places, too, not only these, but the under members of the same series, have been so reduced by denudation as to form valleys, in which the coal measures themselves appear on the surface, as at Hednesford. Sometimes, too, a welcome narrow strip of Permian rock crops up, but nowhere in considerable thickness, and in some instances it is absent altogether.

An interesting experiment, by which the thickness of these rocks was proved, was made by Lord Lichfield, at Rugeley, where the pebble-beds of the Bunter are on the surface. North of Hagley Hall the road appears to be cut through these, whilst on the south, near the Rolling-mill Pool, the boring made through them showed that they were only 269 ft. in thickness. The Permians, down to some red and black marls, succeeded by ironstones and coal, were found to be but 143 feet more. The coal found below the latter, which was 13 inches thick, was supposed to lie beneath the 15th seam of the Brereton Colliery, at which colliery they sank some distance below such coal in red measures. Should this be found to be a correct representation, it is manifest that some 300 ft. of coal measures have been denuded, and their place occupied by Permian and New Red Sandstone rocks. It is, indeed, more than probable that the coal measures, to some extent, have suffered in this district from denudation, seeing that they and the overlying rocks are found dipping in opposite directions. It is to be hoped, however, that the borers in this instance were deceived, although some colouring seems to have been given to their view of the case by the fact that the Bunter comes down upon the coal measures at Brereton, whilst at Rugeley there intervenes, according to the boring, what were supposed to be 140 ft. of Permian rocks.

I confess I should not have ventured to have given the opinion of others that this first coal in the boring at Hagley Park represents the coal measure series beneath the Fifteenth coal, on any slight authority; but finding it given by Mr. Hull, than whom we have not a higher authority on the Triassic series of the Midland Counties, and finding, also, that he had quoted it from the late Mr. Bete Jukes, who referred to the Government horizontal sections of the survey in his book, I have ventured to do so. I am, nevertheless, of opinion that the borers were deceived, and that the coal they met with was really one of the first coals since found in the Rugeley and Cannock shaft. I can readily understand how a mistake of this kind might have been committed by not very careful or observant men. They bored, it is true, to the *same depth* at which the *Fifteenth coal* is found at Brereton; but by far the greater portion of the strata they went through was absent at Brereton, and thus the mistake might have occurred. Rather than a lower coal underneath the Fifteenth coal at Brereton, it seems to me more likely to have been the impure black ring of coal met with, 15 in. thick, at 15 yards from the surface in the shaft of the Cannock and Rugeley Colliery; and this is the more probable as the sinkers met with dark clunches, black marl, &c., before coming to the coal alluded to, and also a fire-clay immediately underneath it, although not quite so thick as that which the borers describe. The red, white, and brown rocks, with red and white marls succeeding, also correspond. There can, then, be little doubt that had the borers gone on they would have found the whole of the measures, down to the Fourteenth or Fifteenth coal. Since writing thus far, I have sent over to make enquiries, and have ascertained from a gentleman interested in one of the largest collieries there that his opinion coincides with my own—that there exists no good ground for saying that the coal reached at Hagley was one occupying a position under the Fifteenth Brereton coal. I conclude, therefore, that had the borers gone on *they would have met with the entire series found at the Rugeley and Cannock Chase Colliery*; and I take leave of this part of my subject, for the present, by reiterating the opinion that there yet remains a valuable unwrought mineral tract at this, the northern, end of the South Staffordshire coal field, and that beneath a surface which having been mapped by the Government Surveyors as the conglomerate beds of the Bunter, has hitherto deterred persons from testing its worth. In many cases these beds, so mapped, will prove to be nothing more than thin coverings of loose gravel, and that over much of Lord Hatherton's property, on the Stafford side of Cannock Chase, as well as on the Rugeley side.

I found in my interviews with mining surveyors and local authorities on the subject that great differences of opinion exist relative to the identity of the members of the Thick coal, which have been supposed to split up in this direction, and which are supposed to be divided, by masses of shales and other measures, from each other. It is quite certain that the Thick coal does become divided into a series of distinct seams to the north-west; and the fact that certain shales and rocks come wedging in from the north seems to suggest that from the north, or north-west it might be, the greatest amount of sediment was brought; and that the force of the water to carry that sediment expended itself as it travelled south. It is also an interesting feature connected with these coal beds that, whether found together or widely separated from each other, they maintain pretty much the same total thickness. What seems surprising is that such a large mass of coal should exist without any intermixture of sand or clay through an area of such great extent, and, at the same time to find the ten or a dozen seams of which it is composed branching off to the north-west. Evidently, there was one favoured spot, or sheltered swamp, where vegetation flourished unaffected by disturbances for considerable periods. There must have been a dense growth of vegetation, through which fluviatile waters passed, and became filtered in their course, similar to what is now going on on the margins of forest-covered swamps in the valley and delta of the Mississippi, where the waters clear themselves entirely before reaching areas in which vegetable matters accumulate for centuries. There might have been a country sloping down to the north and north-west, and a succession of subsidences, where we find these intrusive beds of sediment increasing in number and in thickness. At any rate, after each intrusion of earthy matter a rank mantle of vegetation again spread from the sheltered southern centre to the north-west. Still, each influx of water affected the great central accumulation of matter just sufficient to have left its impression in the shape of the seams, or partings, which enable the Thick coal colliers to recognise each section, like parts of a child's puzzle, whether together or widely separated.

It might be supposed that the Ten-yard coal, owing to the uninterrupted growth of vegetation during the ages upon ages which must have transpired whilst it was accumulating would have been greater even than it is; but this might be accounted for by the fact that each new accumulation along the incline was calculated to stimulate the growth of vegetation, by affording a more congenial soil, according to our modern experience of irrigation. There is a slight increase, however, of thickness of carbonaceous matter where the Thick coal is found undivided, but the difference between this and the whole of the separated coals taken together is by no means considerable. In an interesting discussion which took place last week before the Society of Arts on the profitable utilisation of peat, it was said to be admitted by geologists that peat was coal in its primary condition; that coal once existed in the spongy state of moist peat (as the ferns, horsetails, &c., found embedded in it proved). It was also shown that peat contained from 75 to 90 per cent. of water, and that in order to obtain 1 ton of dry fuel you had to condense at least 10 tons of material. Now, we can scarcely imagine that this 10 tons of peat reduced to 1 ton of peat coal would be equal to the condensing process which had taken place in the production of coal. Nevertheless, if we take the proportions given, and multiply the 30 feet of Thick coal by 10, we find that there must have been at the very least 300 feet of vegetable matter to produce it!

Mr. Beckett has described in the "Geological Journal," a forest of those singular-looking trees, called Sigillaria, 73 of which, I believe, were found where they are supposed to have grown, within a quarter of an acre, in an open work at Park Fields; and I may add that in every one of the Shropshire coals which I have examined with that view I have found myriads of the seedcases of one species of that plant, the Sigillaria Goldenburg. Thus the process of building up the coal measures was evidently a slow one—one which had been going on during very long periods of time. The vegetation of the period became interstratified, as we have seen, with clays, shales, and sand beds, the result of grindings and washings carried on by the machinery of waves and streams, brought about often by a succession of subsidences and elevations, to which the surface appears to have been subject then much more than now.

The sinkings at Hednesford are superintended by a friend of mine, who has had considerable experience in North Staffordshire, and than whom no man is better qualified to classify them. He is also attentively examining every inch of the strata passed through for organic remains, which correspond sufficiently with those found in the Shropshire field to show a relationship between them. The gentleman I allude to, Mr. Molyneux, F.G.S., is preparing a section of these measures, and also a paper, which he will read before the Geological Society, to which I shall look forward with much interest.

In my next I propose taking an underground peep at the "Dusky Realms of the Iron Kings."

Boring Machines at the Mont Cenis Tunnel.—Prof. Ansted says that it is a curious and instructive sight to see a workman connect an elastic tube of about half an inch diameter with one of these machines, and watch the result when a small tap is turned. A piston rod, working in an exceedingly small and short cylinder, immediately flies backwards and forwards with wonderful rapidity, regulated by a small but rather heavy fly-wheel. Immediately a ponderous chisel, 6 or 7 feet long and more than an inch in diameter, is set in motion, and, having been previously placed in position, strikes a succession of heavy blows against the stone. Fragments begin to fly in all directions. Each time that the chisel strikes it is withdrawn a little way, very slightly turned, and immediately strikes again in the same hole. The stone experimented upon being of the hardest and toughest kind the effect is not seen for several strokes; but within two minutes, during which the writer watched the experiment, a steel chisel was completely blunted and rendered useless, and there was a hole made about 2 inches deep in the mass of quartzite placed to operate upon. It is evident that nothing can resist such an attack; and, indeed, holes are bored in this way in an hour that would formerly have taken a day. The machines occupy very little space, and are by no means cumbrous. They can very easily be moved when and where they are needed. As many as 17 are at work together in the end of the tunnel where the advance is being made. As the power is compressed air, they not only add no heat to the interior, but render it cooler by the absorption of heat during expansion. The air, when it escapes, is available for ventilation. It would be quite impossible to carry steam at a high pressure through pipes four miles long, but little diminution of force is experienced in working with the air, although all the engines and condensers, as well as the cylinders for storing the air, are outside the mouth of the tunnel. The length of pipe at present on the Piedmont side is about 4¼ miles. The pressure of air commonly employed is about six and a half atmospheres, or nearly 100 lbs. on the square inch.

Weighing Machines.—The invention of Mr. A. Ody, Bristol, consists in mounting the transverse or main lever of the machine on a fulcrum placed at the centre beneath the table or weighing platform by which it is carried. The table is carried on bearings at the extremities of the side levers in the usual manner, the inner ends of which levers take under the short end of the main or transverse lever before referred to, the other end of which is connected to a steelyard, or weighing lever, as usual.

Treating Calcined Pyrites.—Mr. T. Bell, Walker Ironworks, Northumberland, having obtained a supply of calcined pyrites from processes in which they are produced in a powdery state, places them in a trough or vessels, to which water is supplied either in a continuous current or otherwise, and agitates the material by means of stirrers, the effect whereof is to suspend in the water the fine powder of the calcined pyrites, which is conveyed away with the water into suitable tanks or receivers connected with the trough or vessels for the purpose of receiving the same. The powder is allowed to deposit itself, and the clear water is run off and applied, if desired, to preparing fresh calcined pyrites.

Decomposing Sulphides.—The invention of Mr. W. Gossage, Widnes, consists in obtaining hydrate of soda and sulphide of hydrogen by the decomposition of sulphide of sodium by the action of vapour of water at a high temperature thereon; also hydrate of potassa and sulphide of hydrogen by the decomposition of sulphide of potassium by the action of vapour of water at a high temperature thereon; and lime and sulphide of hydrogen by the decomposition of sulphide of calcium by the action of vapour of water at a high temperature thereon.

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